

REMARKS

The Examiner's indication that the information items submitted with the Information Disclosure Statement of October 18, 2000 have been considered is greatly appreciated.

The specification has been amended merely to address punctuation oversights. No new matter has been added by virtue of these amendments.

Claim 11 has been amended merely to recite terms consistently. Claims 18 and 20 have been amended merely to address punctuation and spelling oversights. These claims have not been narrowed by virtue of these amendments. No new matter has been added by virtue of these amendments.

Claims 1, 2, 4, 9 and 10 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over U.S. Patent No. 6,130,156 to Havemann *et al.* (hereinafter, simply "Havemann") in view of U.S. Patent No. 6,156,861 to Liu *et al.* (hereinafter, simply "Liu"). These rejections are respectfully traversed.

At the outset, the Examiner's concession (Office Action, page 3) regarding Havemann's failure to teach depositing a titanium layer by physical vapor deposition ("PVD") is confirmed and much appreciated. It follows that Havemann also fails to teach or suggest depositing a titanium layer by PVD wherein the atmosphere in the deposition chamber comprises hydrogen.

The Examiner nonetheless states that "Havemann *et al.* disclose a method of forming a layer on a substrate where a titanium layer (9) is formed, in an argon-hydrogen environment, on a substrate...." Applicants respectfully disagree. The only context in which Havemann mentions an argon-hydrogen environment concerns cleaning carbon from a via by sputter etching in an argon-hydrogen environment. This occurs prior to any depositing of a titanium layer in the via. (See Havemann, col.3, lines 55-65.) The sputter etching of carbon residue from a via is not a teaching or a suggestion of anything regarding a completely separate deposition process. It is respectfully submitted that the Examiner has misconstrued Havemann and that such misconstruction is fatal to the rejections of Claims 1, 2, 4, 9 and 10, the texts of which appear in Appendix 3.

Even if Liu were capable of combination with Havemann, *arguendo*, Liu fails to cure the above-remarked deficiencies of Havemann. That is, while the Examiner states that "[Liu discloses] a method of forming a metal layer over a substrate where a titanium layer is sputter deposited by PVD...", Liu clearly fails to teach or suggest PVD deposition of a metal layer in

an atmosphere that comprises hydrogen. Thus, even if Havemann and Liu were somehow capable of combination, *arguendo*, one of ordinary skill in the art at the relevant time would not have arrived at a method which comprises, *inter alia*, depositing a metal layer onto a substrate by PVD wherein the atmosphere in the deposition chamber comprises hydrogen.

Further, it is submitted that the combination of Havemann and Liu hypothesized by the Examiner is impermissible, as there is no teaching or suggestion in either Havemann or Liu, and was no motivation from the art at the time of the invention, to support the modification of Liu's deposition process such that it is carried out in the argon-hydrogen environment of Havemann's pre-deposition, sputter-etch, via-cleaning process. Indeed, the Examiner points to Liu's motivation of preventing hydrogen diffusion (Office Action, page 3), which would have motivated one of ordinary skill in the art at the relevant time to, if anything, avoid the hydrogen-containing environment of Havemann's pre-deposition, sputter-etch process.

Thus, the combination of Havemann and Liu, were it permissible, *arguendo*, fails to teach or suggest a method comprising, *inter alia*, depositing a metal layer onto a substrate by PVD wherein the atmosphere in the deposition chamber comprises hydrogen.

Similarly, the hypothetical combination of Havemann and Liu fails to teach or suggest the method of Claim 2, for at least the reasons set forth above; the method of Claim 4 in which, *inter alia*, the atmosphere associated with PVD comprises argon and hydrogen; the method of Claim 9, involving, *inter alia*, introducing a quantity of hydrogen into the deposition chamber without providing power to the target; and the method of Claim 10, involving, *inter alia*, introducing a quantity of hydrogen into the deposition chamber without providing power to the target, wherein the introducing is flowing a gas comprising hydrogen into the deposition chamber. The Examiner has not provided a *prima facie* showing otherwise. As mentioned above, the argon-hydrogen atmosphere of Havemann is associated only with a via cleaning, sputter-etch process, and even if combinable with Liu, *arguendo*, Liu discloses no hydrogen or argon for its deposition process and teaches the avoidance of hydrogen diffusion.

In view of the foregoing, it is believed that the rejections of Claims 1, 2, 4, 9 and 10 over Havemann in view of Liu have been overcome.

Claims 3, 18, 20 and 21 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Havemann in view of Liu, as applied to Claims 1, 2, 4, 9

and 10 above, and further in view of U.S. Patent No. 6,083,830 to Yamadai (hereinafter, simply "Yamadai"). These rejections are respectfully traversed.

As set forth above, the hypothetical combination of Havemann in view of Liu is not believed to be applicable to Claims 1, 2, 4, 9 and 10. The remarks above concerning the inapplicability of the hypothetical combination as to these underlying claims are incorporated herein by reference.

The hypothetical combination of Havemann in view of Liu is further not believed applicable to Claims 3, 18, 20 and 21. The Examiner's concession as to the failings of Havemann as to Claims 1, 2, 4, 9 and 10, as mentioned above, and his further concession as to the failings of Havemann as to these Claims 3, 18, 20 and 21 (Office Action, page 3) are appreciated and confirmed. The Examiner does not allege that Liu in any way makes up for these many failings of Havemann as to Claims 3, 18, 20 and 21, relying on Yamadai as allegedly making up for these failings.

However, just as Havemann and Liu fail to teach or suggest the use of an atmosphere comprising hydrogen in connection with deposition, so does Yamadai. The Examiner has not shown otherwise. Thus, even if Havemann, Liu and Yamadai were capable of combination, *arguendo*, such a combination would be insufficient as applied to Claims 3, 18, 20 and 21 to support these rejections.

In view of the foregoing, it is believed that the rejections of Claims 3, 18, 20 and 21 have been overcome.

Claims 5 and 8 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Havemann in view of Liu and Yamadai, as applied to Claims 1-4, 9, 10, 18, 20 and 21 above, and further in view of U.S. Patent No. 5,466,522 to Freeman *et al.* (hereinafter, simply "Freeman"). These rejections are respectfully traversed.

At the outset, it is pointed out that the Examiner applied the hypothetical combination of Havemann in view of Liu and Yamadai to Claims 3, 18, 20 and 21 above, and not to Claims 1, 2, 4, 9 and 10, such that the basis of the rejection as set forth in the Office Action (see page 4) is unclear.

As set forth above, the hypothetical combination of Havemann in view of Liu is not believed to be applicable to Claims 1, 2, 4, 9 and 10, and the hypothetical combination of Havemann in view of Liu and Yamadai is not believed to be applicable to Claims 3, 18, 20 and 21. The remarks above concerning the inapplicability of the hypothetical combination or combinations as to these underlying claims are incorporated herein by reference.

The hypothetical combination of Havemann in view of Liu and Yamadai is further not believed applicable to Claims 5 and 8. The Examiner's concession as to the failings of Havemann as to Claims 1, 2, 4, 9 and 10, as mentioned above, his further concession as to the failings of Havemann as to Claims 3, 18, 20 and 21, as mentioned above, and his further concession as to the failings of Havemann as to Claims 5 and 8 (Office Action, page 4) are appreciated and confirmed. The Examiner does not allege that Liu or Yamadai in any way makes up for the many failings of Havemann as to Claims 5 and 8, relying on Freeman as allegedly making up for these failings.

However, Freeman concerns a method of producing a thin film magnetic medium comprising an alloy of cobalt platinum. The Examiner fails to provide a *prima facie* showing as to any motivation one of ordinary skill in the art at the relevant time would have had for combining this disparate teaching of Freeman, regarding deposition of a cobalt platinum alloy to produce a thin film magnetic medium, with any or all of Havemann, Liu and Yamadai. It is submitted that conditions, such as a choice of gases and concentration of same, suited to the deposition of one material, such as an alloy of cobalt platinum, to produce a particular product, such as a thin film magnetic medium, are not readily applicable to the deposition of completely different materials to produce completely different products.

It is submitted that the Examiner has not provided an adequate *prima facie* explanation for this hypothetical combination. That is, while the Examiner points to the coercivity properties of the magnetic cobalt platinum alloy of Freeman, which is of interest in the field of thin film magnetic media, he fails to show how or why one of ordinary skill in the art at the time of the invention would have been motivated to consider same in connection with titanium films. None of Havemann, Liu and Yamadai discuss coercivity or any other magnetic properties of films, or express any interest in coercivity or any other magnetic properties of films. Thus, it is submitted that one of ordinary skill in the art at the relevant time would not have considered Freeman in combination with Havemann, Liu and Yamadai, as hypothesized by the Examiner, and would not have arrived at Freeman's concentrations of hydrogen, particularly given Liu's negative teaching regarding hydrogen diffusion problems.

Further, it appears that the Examiner is taking the position that Havemann could have been modified by Freeman in terms of the hydrogen concentration used during sputter deposition for the purposes of improving coercivity. The Examiner does not appear to be appreciating that Havemann teaches CVD, not sputter deposition, which CVD does not involve hydrogen at all (see remarks above). Further, the Examiner does not appear to be

appreciating Liu's negative teaching regarding hydrogen. Still further, the Examiner has not explained why one of ordinary skill in the art would have been interested in coercivity when there appears to be no interest expressed in the magnetic properties of titanium films. It is submitted that the combination of Havemann, Liu, Yamadai and Freeman is improper and that even if such a combination were somehow possible, *arguendo*, such a combination would be insufficient to support these rejections.

In view of the foregoing, it is believed that the rejections of Claims 3, 18, 20 and 21 have been overcome.

Claims 6 and 7 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Havemann in view of Liu and Yamadai, as applied to Claims 1-4, 9, 10, 18, 20 and 21 above, and further in view of U.S. Patent No. 6,139,922 to Kaloyeros *et al.* (hereinafter, simply "Kaloyeros"). These rejections are respectfully traversed.

At the outset, it is pointed out that the Examiner applied the hypothetical combination of Havemann in view of Liu and Yamadai to Claims 3, 18, 20 and 21 above, and not to Claims 1, 2, 4, 9 and 10, such that the basis of the rejection as set forth in the Office Action (see page 5) is unclear.

As set forth above, the hypothetical combination of Havemann in view of Liu is not believed to be applicable to Claims 1, 2, 4, 9 and 10, and the hypothetical combination of Havemann in view of Liu and Yamadai is not believed to be applicable to Claims 3, 18, 20 and 21. The remarks above concerning the inapplicability of the hypothetical combination or combinations as to these underlying claims are incorporated herein by reference.

The hypothetical combination of Havemann in view of Liu and Yamadai is further not believed to be applicable to Claims 6 and 7. The Examiner's concession as to the failing of Havemann as to Claims 1, 2, 4, 9 and 10, as mentioned above, his further concession as to the failings of Havemann as to Claims 3, 18, 20 and 21, as mentioned above, and his further concession as to the failings of Havemann as to Claims 6 and 7 (Office Action, page 5) are appreciated and confirmed. The Examiner does not allege that Liu or Yamadai in any way makes up for the many failings of Havemann as to Claims 6 and 7, relying on Kaloyeros as allegedly making up for these failings.

However, Kaloyeros teaches directly against titanium and titanium nitride technology as inadequate, abandoning such technology altogether in favor of tantalum and tantalum nitride technology. (See, for example, Kaloyeros, col.1, line 52 to col.2, line 21.) Kaloyeros provides no teaching or suggestion that the vaporizing conditions used in his CVD process for

tantalum-based materials are in any way applicable to the titanium-based materials he abandons. Further, when discussing the vaporizing conditions associated with his CVD process for tantalum-based materials, Kaloyeros makes no mention of sputtering, a sputtering target, or a power density on a sputtering target. A plasma power density is not the same as a power density relative to a target, and the Examiner has failed to show otherwise. Still further, Kaloyeros provides no teaching or suggestion that the vaporizing conditions used in his CVD process concerning tantalum-based materials, which in any event does not involve sputtering, a sputtering target, or a power density on a sputtering target, are in any way applicable to a PVD process, as he does not even mention a PVD process. Still further, the only reference in the hypothetical combination discussing a PVD process is Liu, and that reference provides a negative teaching with respect to hydrogen.

It is submitted that the combination of Havemann, Liu, Yamadai, and Kaloyeros, as hypothesized by the Examiner, is not permissible, and were it permissible, *arguendo*, would be insufficient as applied to Claims 6 and 7. In view of the foregoing, it is believed that the rejections of Claims 6 and 7 have been overcome.

Claims 11-17 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Havemann in view of Liu, Yamadai and Kaloyeros, as applied to Claims 1-4, 6, 7, 9, 10, 18, 20 and 21 above, and further in view of U.S. Patent No. 6,124,154 to Miyasaka (hereinafter, simply "Miyasaka"). These rejections are respectfully traversed.

At the outset, it is pointed out that the Examiner applied the hypothetical combination of Havemann in view of Liu, Yamadai and Kaloyeros to Claims 6 and 7 above, and not to Claims 1-4, 9, 10, 18, 20 and 21, such that the basis of the rejection as set forth in the Office Action (see page 6) is unclear.

As set forth above, the hypothetical combination of Havemann in view of Liu is not believed to be applicable to Claims 1, 2, 4, 9 and 10; the hypothetical combination of Havemann in view of Liu and Yamadai is not believed to be applicable to Claims 3, 18, 20 and 21; and the hypothetical combination of Havemann in view of Liu, Yamadai and Kaloyeros is not believed to be applicable to Claims 6 and 7. The remarks above concerning the inapplicability of the hypothetical combination or combinations as to these underlying claims are incorporated herein by reference.

The hypothetical combination of Havemann in view of Liu, Yamadai and Kaloyeros is further not believed applicable to Claims 11-17. The Examiner's concession as to the failing of Havemann as to Claims 1, 2, 4, 9 and 10, as mentioned above, his further concession as to

the failings of Havemann as to Claims 3, 18, 20 and 21, as mentioned above, his further concession as to the failings of Havemann as to Claims 6 and 7 (Office Action, page 5), and his further concession as to the failings of Havemann as to Claims 11-17 are appreciated and confirmed. The Examiner does not allege that Liu or Yamadai or Kaloyeros in any way makes up for the many failings of Havemann as to Claims 11-17, relying on yet another reference, Miyasaka, as allegedly making up for these failings.

However, Miyasaka concerns a melt crystallization process performed in either a hydrogen-containing atmosphere or a reducing argon-containing atmosphere. The Examiner has failed to provide a teaching or suggestion to support the combination of this teaching regarding melt crystallization with references that concern via-cleaning, sputter-etching (Havemann), PVD where hydrogen is problematic (Liu), sputtering without hydrogen (Yamadai), and CVD for tantalum-related materials as explicitly distinct from titanium-related materials (Kaloyeros).

Even if the hypothetical combination of disparate teachings were somehow possible, *arguendo*, it is respectfully submitted that the teaching the Examiner ascribes to Miyasaka is incorrect. That is, the Examiner asserts that Miyasaka "discloses a method of forming a thin film over a substrate (10) in an atmosphere [of] hydrogen in argon with an inert gas" However, Miyasaka discloses use of a hydrogen in an inert gas, such as argon (see col.6, lines 5-10), but does not teach or suggest a further gas, such as an additional inert gas, as the Examiner asserts. Thus, one of ordinary skill in the art would not have arrived at the inventions of Claims 11-17 at the relevant time were the hypothetical combination even possible. Further, as Miyasaka involves melt crystallization, he provides no teaching or suggestion with respect to sputter deposition (Claims 11-17); no teaching or suggestion with respect to a titanium target and a gas injector positioned relative thereto (Claims 14 and 15); no teaching or suggestion with respect to target planarity or hydrogen quantity relative to target surface area (Claim 15); and no teaching or suggestion with respect to power density on a target (Claims 16 and 17). The Examiner has provided no showing otherwise.

It is submitted that the combination of Havemann, Liu, Yamadai, Kaloyeros and Miyasaka, as hypothesized by the Examiner, is not permissible, and were it permissible, *arguendo*, would be insufficient as applied to Claims 11-17. In view of the foregoing, it is believed that the rejections of Claims 11-17 have been overcome.

Claims 19 and 22 have been rejected under 35 U.S.C. Section 103(a) as allegedly being unpatentable over Havemann in view of Liu and Yamadai, as applied to Claims 1-4, 9,

10, 18, 20 and 21 above, and further in view of U.S. Patent No. 6,329,282 to Hsu *et al.* (hereinafter, simply "Hsu"). These rejections are respectfully traversed.

At the outset, it is pointed out that the Examiner applied the hypothetical combination of Havemann in view of Liu and Yamadai to Claims 3, 18, 20 and 21 above, and not to Claims 1, 2, 4, 9 and 10, such that the basis of the rejection as set forth in the Office Action (see page 6) is unclear.

As set forth above, the hypothetical combination of Havemann in view of Liu is not believed to be applicable to Claims 1, 2, 4, 9 and 10, and the hypothetical combination of Havemann in view of Liu and Yamadai is not believed to be applicable to Claims 3, 18, 20 and 21. The remarks above concerning the inapplicability of the hypothetical combination or combinations as to these underlying claims are incorporated herein by reference.

The hypothetical combination of Havemann in view of Liu and Yamadai is further not believed applicable to Claims 19 and 22. The Examiner's concession as to the failings of Havemann as to Claims 1, 2, 4, 9 and 10, as mentioned above, his further concession as to the failings of Havemann as to Claims 3, 18, 20 and 21, as mentioned above, and his further concession as to the failings of Havemann as to Claims 19 and 22 (Office Action, page 7) are appreciated and confirmed. The Examiner does not allege that Liu or Yamadai in any way makes up for the many failings of Havemann as to Claims 6 and 7, relying on Hsu as allegedly making up for these failings.

However, Hsu teaches a passivation process using an in-situ argon and nitrogen plasma to obtain hyper-textured aluminum wherein the x-ray rocking curve FWHM in degrees was measured at 1.5 (see col.3, lines 39-65). Hsu discloses that without his nitrogen-based passivation process, the aluminum curve was measured at 3.8 degrees (see *id.*). Hsu's disclosure thus suggests that without the nitrogen-based passivation process he teaches, one of ordinary skill in the art would not obtain an aluminum layer having a signal of 1.5 degrees or less, but would obtain an aluminum layer having a signal more on the order of 3.8 degrees. Hsu's disclosure provides absolutely no teaching concerning the effect of processes other than his passivation process on aluminum layer signals.

It is submitted that even if Hsu's nitrogen-based passivation process were somehow capable of combination with the three other disparate references, *arguendo*, one of ordinary skill in the art at the relevant time would not have arrived at the inventions of Claims 19 and 22. In view of the foregoing, it is believed that the rejections of Claims 19 and 22 have been overcome.

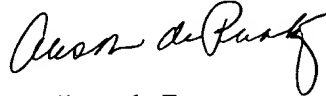
CONCLUSION

Claims 1-22 define novel and non-obvious subject matter of the present invention. Accordingly, an early notification that the application is in condition for allowance is earnestly solicited.

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Appendix 1: Copy of Replacement Paragraph in Marked Form

The replacement paragraph for page 5, lines 6-14, is set forth below in marked form.

PVD is typically performed in a cluster tool, which includes at least a separate module for each layer to be deposited. For example, to produce a Ti/TiN/Al/TiN interconnect stack, titanium is deposited in a first module, titanium nitride in a second, aluminum in a third, and the titanium nitride overlayer in a fourth module. Commercially available PVD cluster tools include the Inova®, provided by Novellus Systems, Inc. (San Jose, CA) and the Endura®, provided by Applied Materials (Santa Clara, CA[.]). Standard PVD processes and equipment are described, for example, in Chapter 10 of "Silicon Processing for the VLSI Era Vol. 1" by Wolf and Tauber (Lattice Press, Sunset Beach, CA, 1986).

Appendix 2: Copy of Amended Claims in Marked Form

11. (Twice Amended) A method of forming an oriented titanium layer on a substrate, the method comprising:

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

sputter depositing the [metal] titanium layer onto the substrate by applying power to the [metal] target and by providing a second gas in the sputtering chamber through a second gas injector, wherein the hydrogen is activated and whereby the deposited [metal] titanium layer has a preferred crystal orientation.

18. (Twice Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing a titanium layer wherein the depositing a titanium layer comprises[;];

placing the substrate in a deposition chamber comprising a source of titanium; and

depositing the titanium layer onto the substrate by physical vapor deposition of the source of titanium under conditions wherein the atmosphere in the deposition chamber comprises hydrogen and wherein the hydrogen is activated, whereby the [titanium] titanium layer has a <0002> preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred <111> crystal orientation.

20. (Twice Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing a titanium layer the titanium layer deposition comprising:

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

sputter depositing the metal layer onto the substrate by applying power to the metal target and by providing a second gas in the sputtering chamber through a second gas injector, wherein the hydrogen is activated and whereby the deposited metal layer has a preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred $\langle 111 \rangle$ crystal orientation.

Appendix 3: Copy of Pending Claims, Including Any Amendment Herein, in Clean Form

1. A method of forming an oriented metal layer on a substrate, the method comprising:

placing the substrate in a deposition chamber comprising a source of metal;

and

depositing the metal layer onto the substrate by physical vapor deposition of the source of metal under conditions wherein the atmosphere in the deposition chamber comprises hydrogen and wherein the hydrogen is activated, whereby the metal layer has a preferred crystal orientation.

2. The method of Claim 1 wherein the source of metal is a sputtering target and wherein depositing the metal layer onto the substrate is sputter depositing the metal layer by applying power to the sputtering target.

3. The method of Claim 2 wherein the metal is titanium and the titanium layer has a preferred <0002> crystal orientation.

4. The method of Claim 2 wherein the atmosphere comprises argon and hydrogen.

5. The method of Claim 3 further comprising flowing a gas mixture comprising at least 0.1 molar percent hydrogen while sputter depositing the titanium layer.

6. The method of Claim 3 wherein applying power to the target is providing a power density on the target of at least about 0.5 watt per square centimeter of target area.

7. The method of Claim 6 wherein applying power to the target is providing a power density on the target of between about 3 and about 8 watts per square centimeter of target area.

8. The method of Claim 5 wherein the concentration of hydrogen in the atmosphere is at least a factor of 3 higher than the concentration of hydrogen in the sputtering chamber when sputter depositing by a process in which no hydrogen is deliberately introduced into the sputtering chamber.

9. The method of Claim 2 further comprising, after placing the substrate in the deposition chamber:

introducing a quantity of hydrogen into the deposition chamber without providing power to the target.

10. The method of Claim 9 wherein introducing a quantity of hydrogen is flowing a gas comprising hydrogen into the deposition chamber.

11. (Twice Amended) A method of forming an oriented titanium layer on a substrate, the method comprising:

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

sputter depositing the titanium layer onto the substrate by applying power to the target and by providing a second gas in the sputtering chamber through a second gas injector, wherein the hydrogen is activated and whereby the deposited titanium layer has a preferred crystal orientation.

12. The method of Claim 11 wherein the first gas comprises argon and hydrogen.

13. The method of Claim 12 wherein the second gas is an inert gas.

14. The method of Claim 12 wherein the first gas injector is positioned proximate the target.

15. The method of Claim 14 wherein the titanium target is planar and wherein flowing the first gas provides a quantity of hydrogen in the sputtering chamber that is at least 0.5×10^{-4} standard cubic centimeters of hydrogen per square centimeter of target surface area.

16. The method of Claim 11 wherein applying power to the target is providing a power density on the target of at least about 0.5 watt per square centimeter of target area.

17. The method of Claim 16 wherein applying power to the target is providing a power density on the target of between about 3 and about 8 watts per square centimeter of target area.

18. (Twice Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing a titanium layer wherein the depositing a titanium layer comprises:

placing the substrate in a deposition chamber comprising a source of titanium; and

depositing the titanium layer onto the substrate by physical vapor deposition of the source of titanium under conditions wherein the atmosphere in the deposition chamber comprises hydrogen and wherein the hydrogen is activated, whereby the titanium layer has a <0002> preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred <111> crystal orientation.

19. The method of Claim 18 whereby a full width at half maximum of a <111> X-ray diffraction signal of the aluminum layer is less than about 1.5 degrees.

20. (Twice Amended) A method of depositing an oriented aluminum layer, the method comprising:

depositing a titanium layer the titanium layer deposition comprising:

placing the substrate in a sputtering chamber comprising a titanium target;

flowing a first gas comprising hydrogen into the sputtering chamber through a first gas injector; and

sputter depositing the metal layer onto the substrate by applying power to the metal target and by providing a second gas in the sputtering chamber through a second gas injector, wherein the hydrogen is activated and whereby the deposited metal layer has a preferred crystal orientation; and

depositing an aluminum layer overlying the titanium layer, whereby the aluminum layer has a preferred $\langle 111 \rangle$ crystal orientation.

21. The method of Claim 20 further comprising depositing a titanium nitride layer overlying the titanium layer, whereby the titanium nitride layer has a preferred $\langle 111 \rangle$ crystal orientation.

22. The method of Claim 20 whereby a full width at half maximum of a $\langle 111 \rangle$ X-ray diffraction signal of the aluminum layer is less than about 1.5 degrees.